

# Excitation-Energy Dependence of Cu $L_{2,3}$ X-Ray Emission Spectra of Cu, Cu<sub>2</sub>O and CuO

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## INTRODUCTION

Cu metal and its oxides have recently attracted considerable attention for the study of the electronic structure of copper oxides based on the superconducting matters. The Cu  $L$  X-ray emission spectra of Cu metal and its oxides have been measured by many laboratories for studying the electronic structure of the valence bands and the effect of chemical bonding on the satellites structure of the main peak of Cu  $L\alpha_{1,2}$  X-ray emission using usual X-ray source [1,2] and synchrotron radiation [3-5]. The incident photon energy dependence was measured for Cu  $L_{2,3}$  satellites using synchrotron radiation [3-5]. Changes in the Cu  $L_{2,3}$  X-ray emission spectra with Cu metal and its oxides have been measured using electron excitation by Fischer [6]. He found that relative intensity  $L\beta_1/L\alpha_{1,2}$  significantly depends on the incident electron energy and the target. The relative intensity  $L\beta_1/L\alpha_{1,2}$  decreases with increase of excitation energy and it increases considerably for the oxides as compared to the metals.

In the present experiment, we have measured excitation-energy-dependence of Cu  $L_{2,3}$  X-ray emission spectra of Cu, Cu<sub>2</sub>O and CuO using synchrotron radiation in order to study the effect of chemical bonding in the excitation and deexcitation processes of inner-shell electrons of Cu metal and its oxides.

## EXPERIMENT

The Cu (99.99 %) foil sample and sintered Cu<sub>2</sub>O (99.9 %) and CuO (99.9 %) samples were commercially obtained. The spectral measurements in the Cu  $L$  region of these samples were performed at the beamline BL-8.0.1 for X-ray emission and fluorescence yield (FY) X-ray absorption measurements and at BL-6.3.1 for total-electron yield (TEY) X-ray absorption measurements.

In order to determine the excitation energies, XA spectra were measured by total electron-yields measurements. The incident photon current was continuously monitored using a gold mesh in

front on the sample to normalize the XE spectra.

## RESULTS AND DISCUSSION

Cu  $L_{2,3}$  X-ray emission (XE) spectra of Cu,  $\text{Cu}_2\text{O}$  and  $\text{CuO}$  spectra were measured at ten different excitation energies from 930~934 eV, at the  $L_3$  threshold energy, up to energies as high as 990 eV, above the  $L_2$  threshold energy. Figure 1 shows Cu  $L_{2,3}$  XE spectra normalized to the integrated photon flux, excited at specific energies. The spectra were measured at 930~934 eV ( $L_3$  threshold), at 950~952 eV ( $L_2$  threshold), and at 990 eV (above the  $L_2$  threshold). The relative intensity  $L\beta_1/L\alpha_{1,2}$  significantly depends on the incident photon energy and the target. The intensity ratio for the Cu target is constant at any incident photon energy. On the other hand, those for the  $\text{Cu}_2\text{O}$  and  $\text{CuO}$  targets are the highest at the  $L_2$  threshold energy, decrease abruptly just after the  $L_2$  threshold energy, and then increase with the incident photon energy. This tendency is of interest from the view of the chemical effects on the excitation and deexcitation processes for inner-shell electrons.

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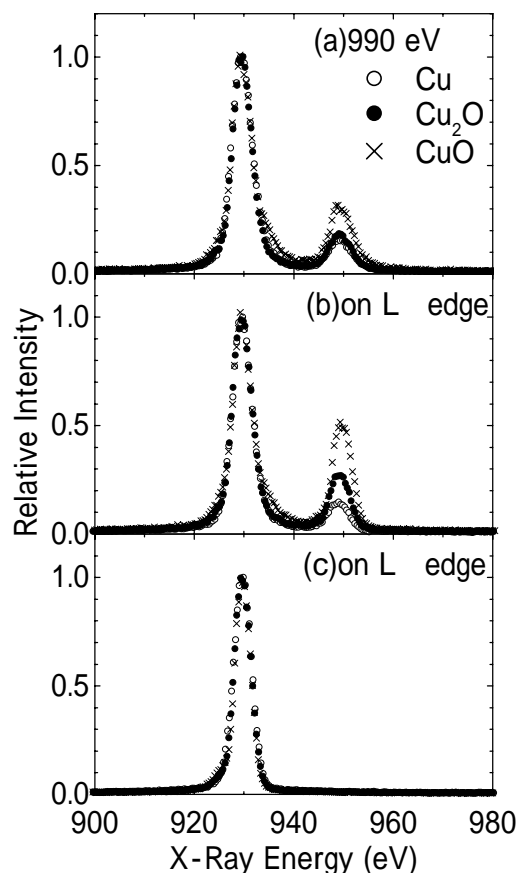


Figure 1. Comparison in the Cu L x-ray emission spectra of Cu,  $\text{Cu}_2\text{O}$  and  $\text{CuO}$ . Excitation energies are tuned at 990eV (a),  $L_2$  (b) and  $L_3$  (c) thresholds.

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